Additive Manufacture of Refractory Metal Propulsion Components, Phase I

Completed Technology Project (2018 - 2019)

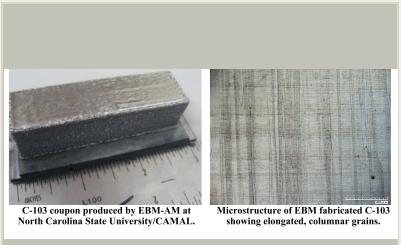
Project Introduction

Niobium alloy (C-103) reaction control system (RCS) chambers have been used on numerous NASA programs. However at elevated temperatures, the strength of C-103 decreases significantly. Higher strength niobium alloys have been developed, but these alloys lack the formability of C-103. Recently, Additive Manufacture (AM) of niobium and C-103 has been demonstrated using powder bed electron beam melting (EBM). A primary advantage of AM processing is its ability to produce complex components to net shape along with the incorporation of unique features. However, EBM-AM processing of niobium and C-103 results in elongated, columnar grains, which reduce mechanical properties as compared to a cold worked material. Therefore, the potential exists to develop and fabricate a higher strength niobium alloy by taking advantage of the net-shape forming capability of AM processing and circumvent the lack of formability of such high strength alloys. To demonstrate the feasibility of EBM-AM processing high strength niobium alloys, a parameters-characterization-properties study will be conducted during Phase I. During Phase II, the EBM-AM processing of high strength niobium alloys will be optimized and extensive materials properties testing will be conducted. The most promising results will then be used to produce a high strength niobium alloy RCS chamber.

Anticipated Benefits

Targeted NASA applications include in-space propulsion components for apogee insertion, attitude control, orbit maintenance, repositioning of satellites/spacecraft, reaction control systems, and descent/ascent engines, nuclear power/propulsion, microgravity containment crucibles and cartridges.

Commercial sectors that will benefit from this technology include medical, power generation, electronics, defense, aerospace, chemicals, and corrosion protection. Targeted commercial applications include net-shape fabrication of refractory metals for rocket nozzles, crucibles, heat pipes, propulsion components, sputtering targets, turbines, rocket engines, and nuclear power components.



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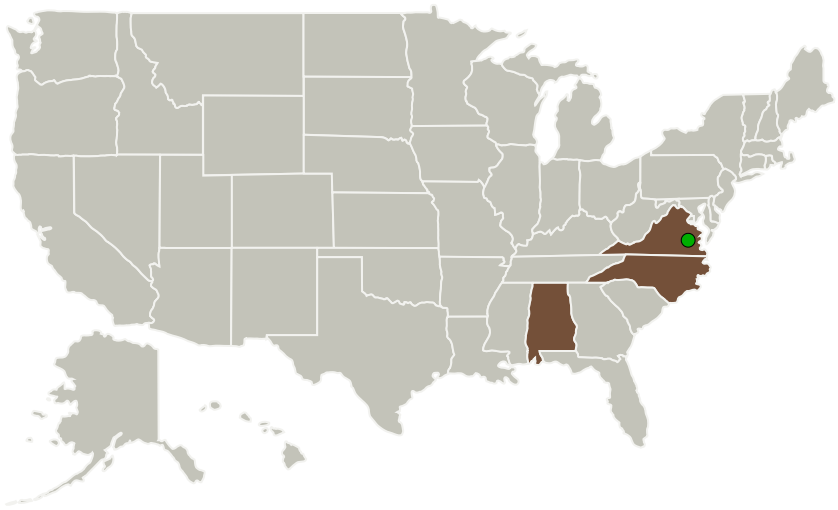
Completed Technology Project (2018 - 2019)

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Geoplasma, LLC	Lead Organization	Industry	Huntsville, Alabama
Langley Research Center(LaRC)	Supporting Organization	NASA Center	Hampton, Virginia
North Carolina State University at Raleigh	Supporting Organization	Academia	Raleigh, North Carolina

Primary U.S. Work Locations	
Alabama	North Carolina
Virginia	

Project Transitions

August 2018: Project Start

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Geoplasma, LLC

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

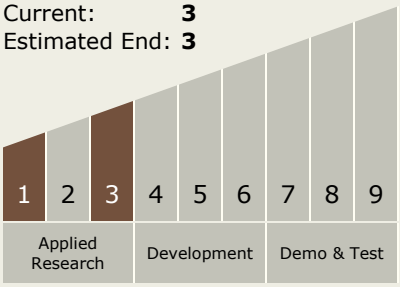
Carlos Torrez

Principal Investigator:

John Scott S O'dell

Technology Maturity (TRL)

Start: **1**
Current: **3**
Estimated End: **3**



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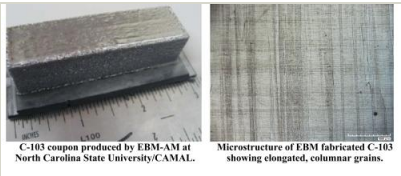
August 2019: Closed out

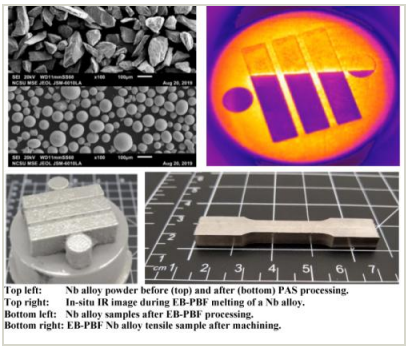
Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/141221)*

Images



Briefing Chart Image
Additive Manufacture of Refractory Metal Propulsion Components, Phase I
(https://techport.nasa.gov/image/133114)



Final Summary Chart Image
Additive Manufacture of Refractory Metal Propulsion Components, Phase I
(https://techport.nasa.gov/image/133214)

Technology Areas

Primary:

- TX09 Entry, Descent, and Landing
  - TX09.3 Landing
    - TX09.3.1 Touchdown Systems

Target Destinations

Mars, Earth, Others Inside the Solar System